Arizona Climate Change Advisory Group Meeting #1

July 14, 2005

ADEQ Arizona Department of Environmental Quality

CCS CENTER FOR CLIMATE STRATEGIES

Introductions

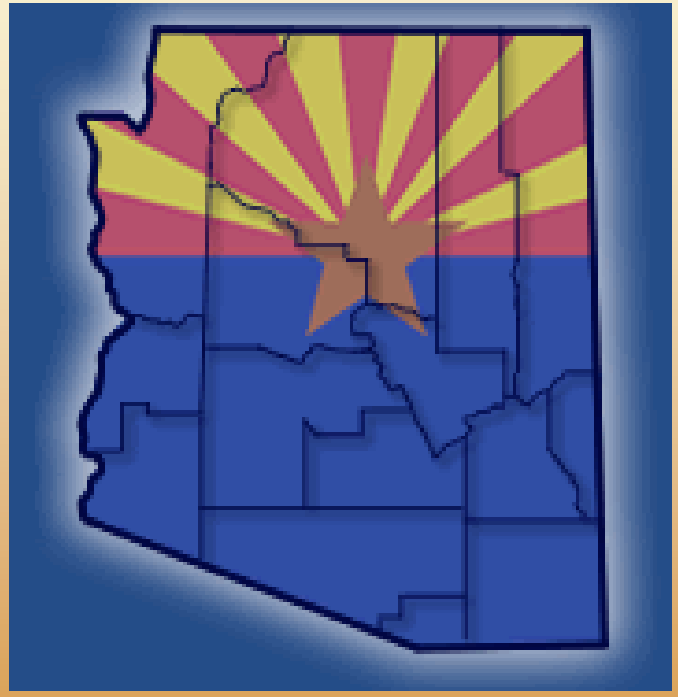
- Governor's Office
- ADEQ & state agencies
- Stakeholders
- Public Observers
- Center For Climate Strategies

Today's Agenda

- Introductions (10 minutes)
- Purpose and goals (10)
- History & status of state climate actions (25)
- Review of the process (20)
- Review of open meetings law (10)
  - Break (5)
- Emissions inventory & forecasts (90)
- Energy and economic modeling (15)
  - Break (5)
- Opportunities & issues (20)
- Technical work groups, next steps (20)
- Public input (10)

Purpose & Goals

- Arizona Executive Order 2005-02
- Arizona Climate Change Advisory Group
- Climate Action Plan
  - Stakeholder policy recommendations
  - Greenhouse gas emissions inventory and forecasts



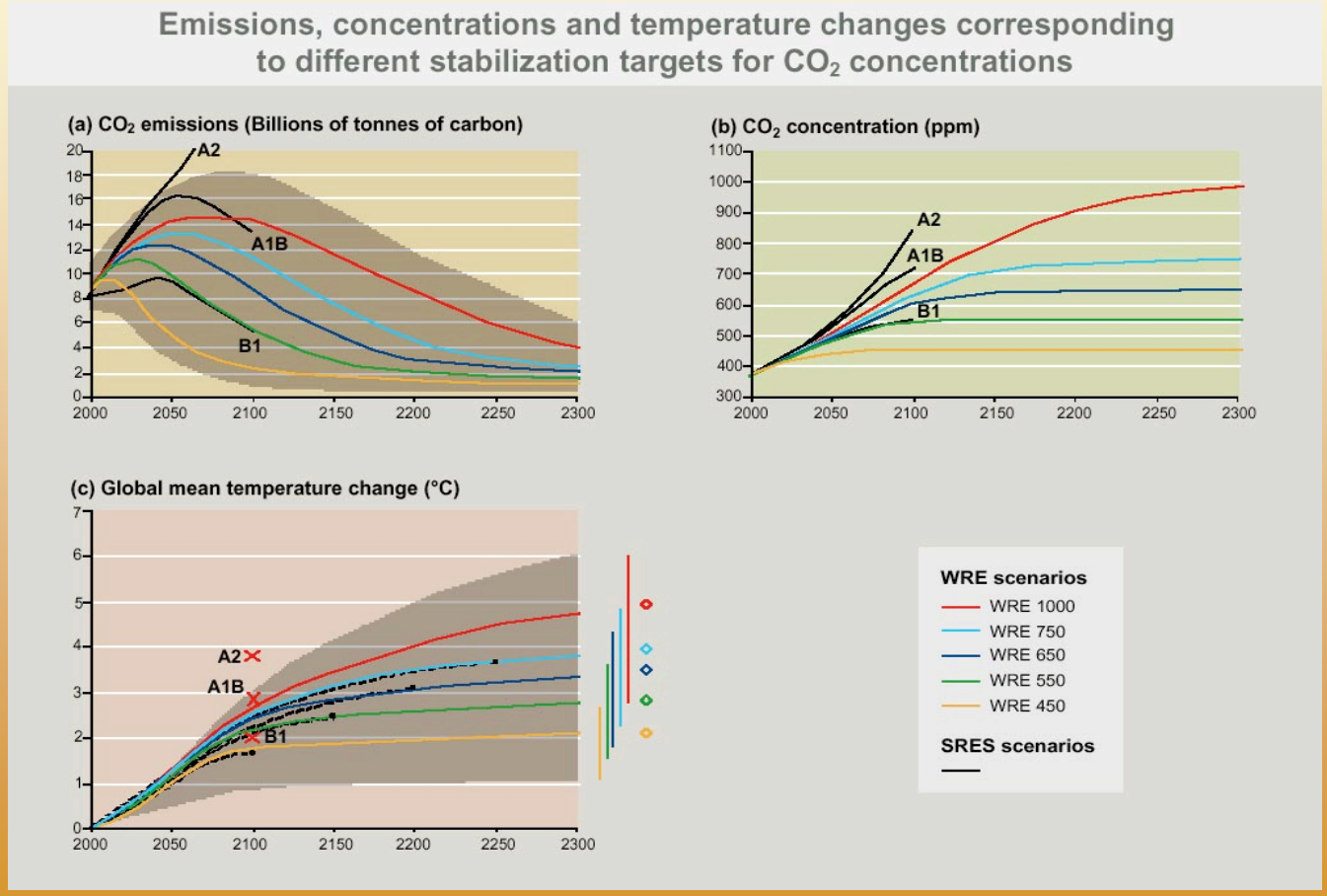
Part 1

- Purpose and goals (10)
- History & status of state climate actions (25)
- Review of the process (20)
- Review of open meetings law (10)

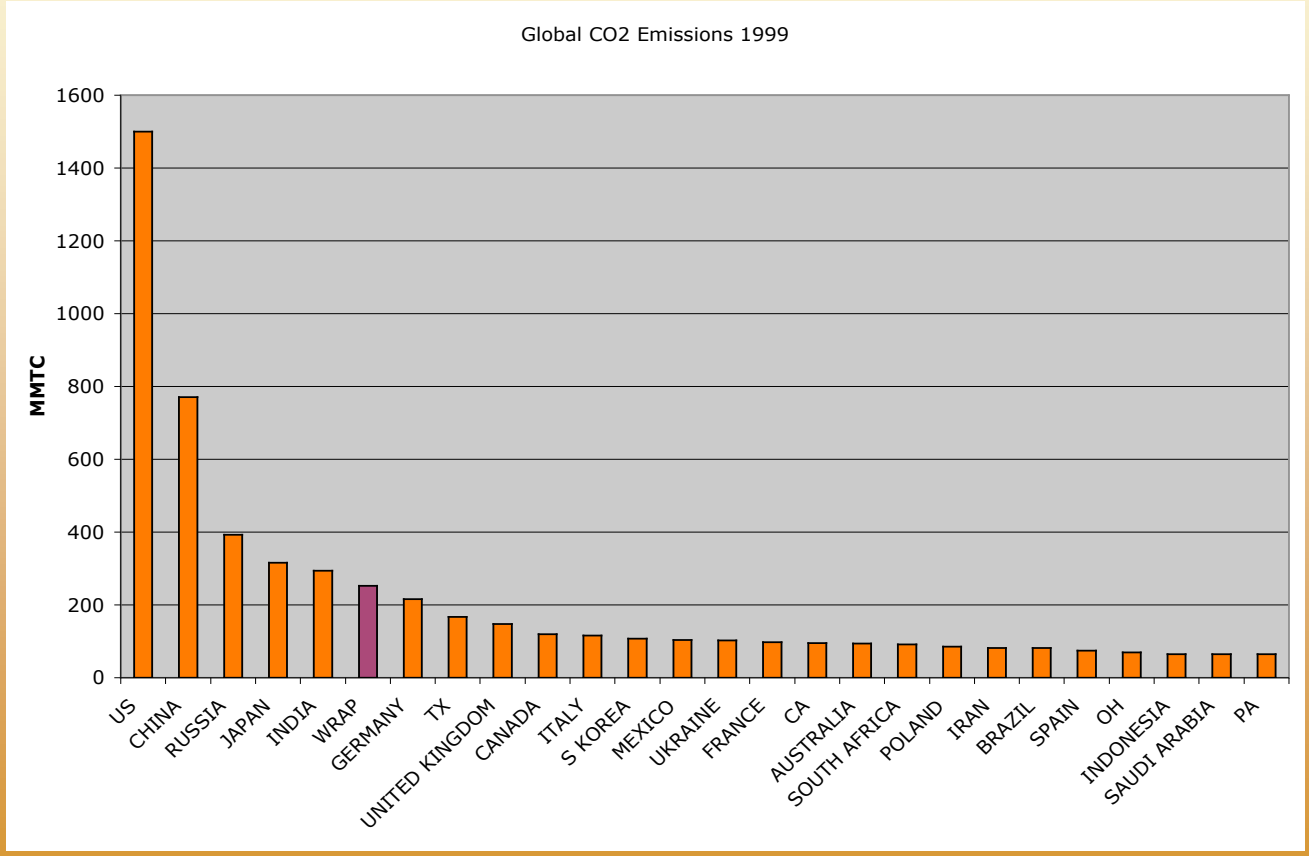
The Challenge

- "The ultimate objective of this Convention .... is to achieve, ... stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system."
  - UNFCCC Article 2 Objective, Rio De Janeiro

The Future?


Emissions, concentrations and temperature changes corresponding to different stabilization targets for CO_2 concentrations
(a) CO_2 emissions (Billions of tonnes of carbon)
A2
A1B
B1
(b) CO_2 concentration (ppm)
A2
A1B
B1
(c) Global mean temperature change (°C)
A2
A1B
B1
WRE scenarios
WRE 1000
WRE 750
WRE 650
WRE 550
WRE 450
SRES scenarios

US State Emissions



Have Faith

- "...As the children stared at the large stone wall around the orchard and wondered how they would ever scale it, one threw his hat over and said: "Now we must find a way"..."
  - Maine Governor John Baldacci, 2003

Reasons For State Action

- Coincidence
- Co Benefits
- Concern about risk
- Cost effective solutions
- Public awareness
- Future markets
- Future mandates
- Leadership

State Policy Evolution

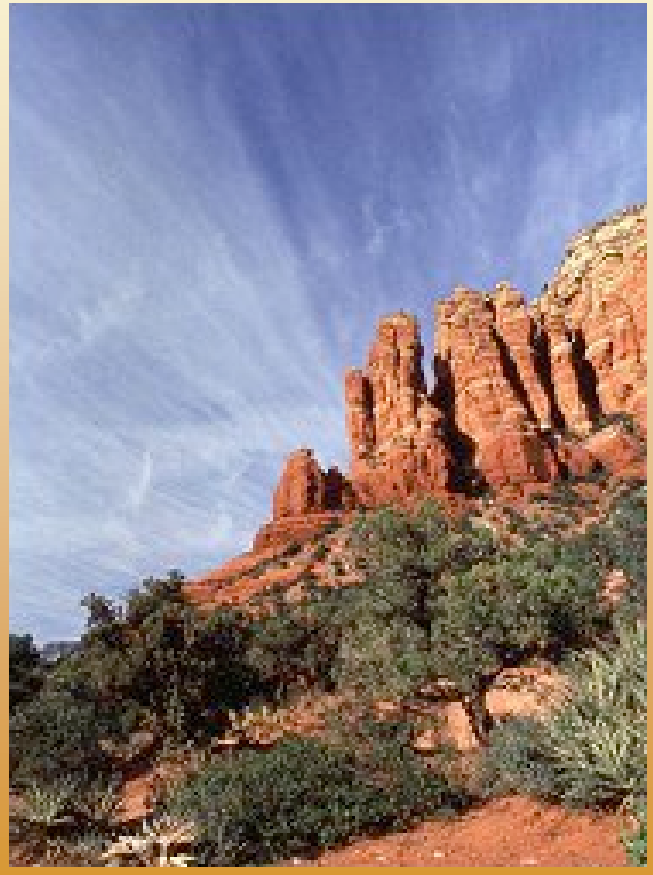
- Learning by Doing
- Learning by Sharing
- Cooperation

Emerging Climate Actions

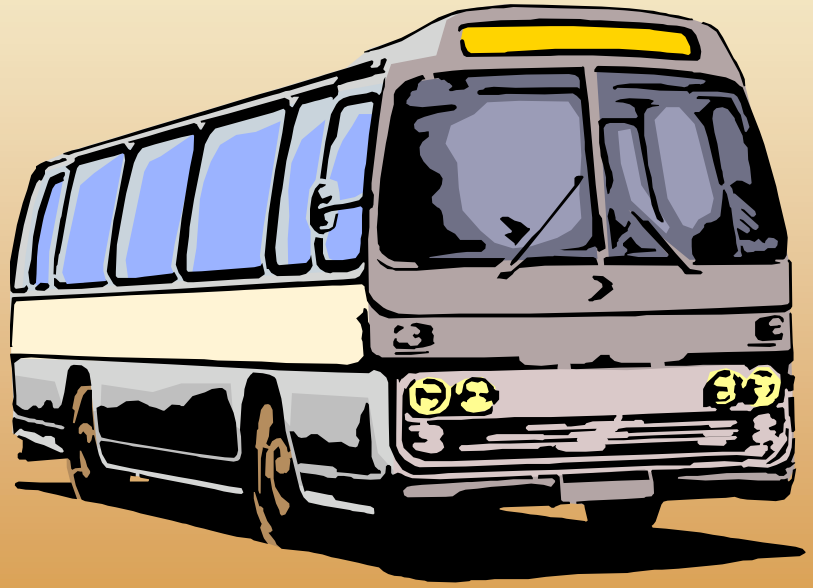
- 200+ types across US States
  - All sectors
  - All mechanisms
- 30 Statewide plans since 1990's
  - 7 completed since 2001
  - More underway
- 4 Regional agreements
  - NEG/ECP, RGGI, PTP, WCCI
- Many local actions
  - Cities and counties
  - Companies and Institutions

Sample Arizona Actions

- Environmental portfolio standard
- Green power purchase
- Appliance and Equipment Energy efficient incentives
- Voluntary building codes
- Solar standards for state buildings
- Transit expansion, light rail
- Travel reduction program



State Sectors



- Energy Supply, including electricity and direct fuels
- Residential, Commercial, Industrial
- Transportation and Land Use
- Agriculture
- Forestry
- Waste Management

Key Action Areas

- Energy efficiency and conservation
- Transportation efficiency
- Low emitting fuels and power, including renewables and advanced technology
- Carbon storage, including terrestrial and geologic
- Process improvements and gas leaks
- Materials and products substitution, including green products
- Waste energy recapture

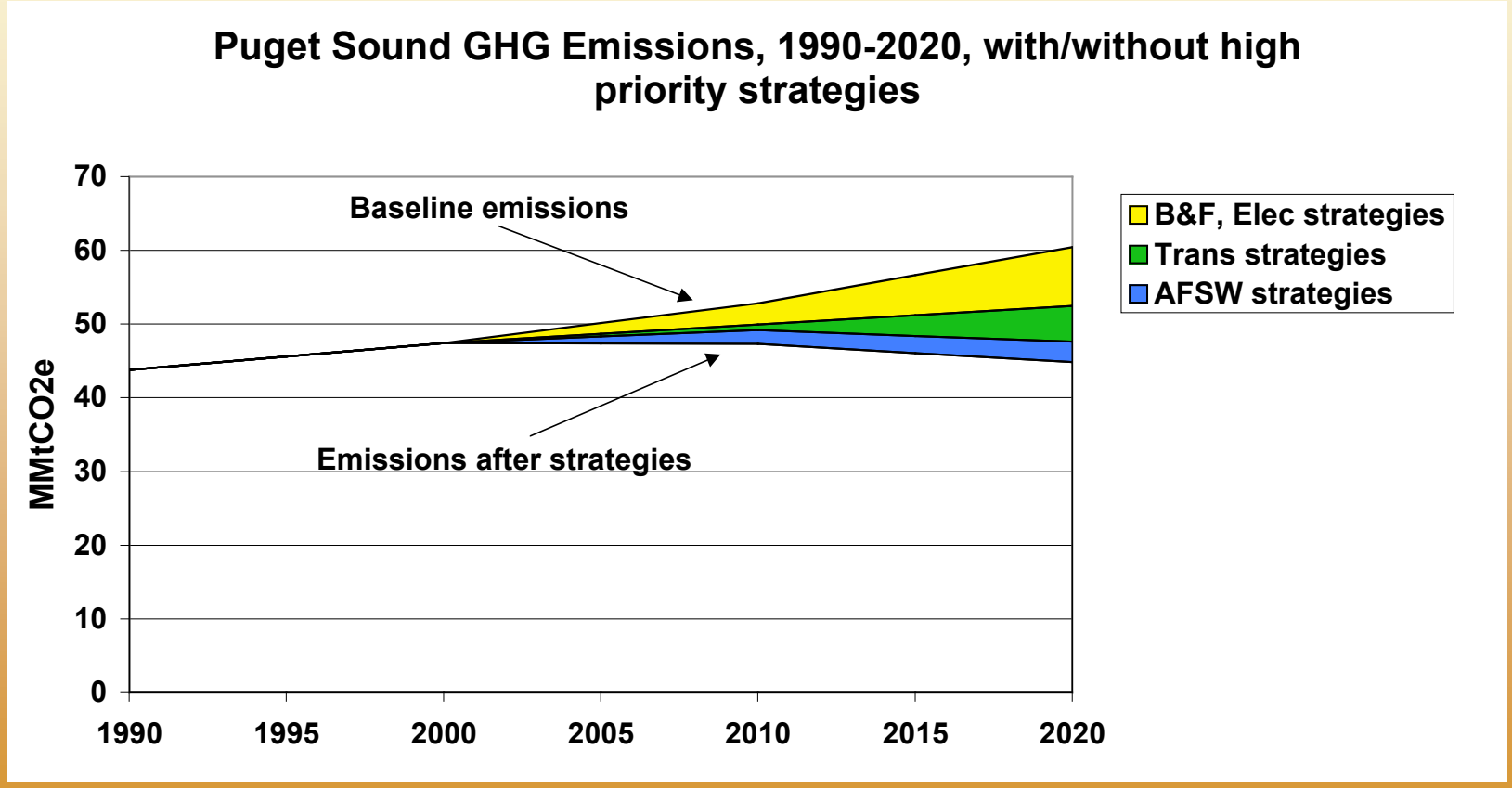
Implementation Mechanisms

- Voluntary Agreements
- Technical Assistance
- Information and Education
- Financial incentives
- Codes and Standards
- Market Approaches
- Reporting and Registries
- Others!

Policy Portfolios

Sector	Mechanism							
	Codes & Standards	Market Mechanisms	Funding Mechanisms	Voluntary Agreements	Technical & Financial Assistance	Information & Education	Pilots & Demos	Reporting & Disclosure
Agriculture								
Commercial, Residential And Industrial								
Energy Supply								
Forestry								
Transportation and Land Use								
Waste Management								
Cross Cutting Issues								

Progress


Puget Sound GHG Emissions, 1990-2020, with/without high priority strategies
MMtCO2e
70
60
50
40
30
20
10
0
1990
1995
2000
2005
2010
2015
2020
Baseline emissions
Emissions after strategies
B&F, Elec strategies
Trans strategies
AFSW strategies

State GHG Plans

State	GHG Forecast	Goal	Result
CT	32% (1990-2020)	NEG/ECP	100%
MA	?	NEG/ECP	?
ME	34%	NEG/ECP	100%
NEG	?	NEG/ECP	TBD
NJ	?	5% -1990 by 2005	100%
NY	24%	5% -1990 by 2010	?
OR	38%	NEG/ECP	85%
Puget	37%	NEG/ECP?	100%
RI	35%	NEG/ECP	100%

Ten Step Work Plan

1. Develop initial GHG inventories and forecasts
2. Identify conceivable GHG mitigation options
3. Identify initial priorities for evaluation
4. Evaluate supply potential, cost effectiveness; ancillary and feasibility issues as needed
5. Identify barriers, alternative policy design needs
6. Modify, add or subtract options as needed
7. Evaluate cumulative results of options
8. Iterate to consensus, with votes as needed
9. Aggregate options into implementation scenarios
10. Finalize recommendations and report language

Advisory Group Process

- Design
- Timing
- Coverage of issues
- Roles and responsibilities
- Guidelines
- Fact finding
- Transparency
- Description of options
- Decision criteria
- Stakeholder decisions
- End product/final report

Process Design

- Stepwise
- Fact based
- Consensus driven
- Self determined
- Informal
- Nonbinding
- Transparent
- Inclusive
- Flexible

Timing

- Stakeholder meetings
  - July, September, December, February, April, May
- Technical work group conference calls
  - Regularly scheduled
- Work Products
  - Initial GHG inventory & forecast: June 30, 2005
  - Review of draft final report: May 30, 2006
  - Report to the Governor: June 30, 2006

Coverage Of Issues

- All GHG's, Black Carbon?
- All sectors
- All implementation mechanisms
- State and multi state actions
- 1990, 2000, 2010 and 2020 time periods

Roles & Responsibilities

- Process Convened by Governor Janet Napolitano
- ADEQ provides coordination and organization
- State agencies act as advisors
- Stakeholders make recommendations
- Technical work groups advise stakeholders
- Public input and review for stakeholders
- CCS provides evaluative facilitation, final report

Participant Guidelines

- Continuity; attendance at all meetings
- Active involvement in proposals and evaluations
- Good faith participation and support of the process
- Fact based offers and statements, no personal criticisms
- Do not represent the state or stakeholder process to the media

Fact Finding

- Preliminary fact finding
  - Inventory and forecast of GHG emissions
  - Inventory of actions, studies, advisory groups
- Joint fact finding
  - Inventory and forecast of emissions, potential solutions, priorities for analysis
  - Evaluation approaches
- Joint policy development
  - Policy design specifications, implementation mechanisms, alternative solutions, final recommendations

Transparency

- Explicit Policy Design
  - Timing, levels, coverage, implementation methods, etc.
- Evaluation Approach
  - Data sources
  - Quantification methods
  - Key assumptions

Policy Description

- Policy Description
- BAU Policies/Programs
- Types(s) of GHG Benefit(s)
- Types of Ancillary Benefits and or Costs
- Estimated GHG Savings and Costs Per MMTCO2e
  - Insert Excel Worksheet
- Data Sources, Methods and Assumptions
  - Data Sources
  - Quantification Methods
  - Key assumptions
- Key Uncertainties
  - Benefits
  - Costs
- Description of Ancillary Benefits and Costs, If Needed
  - Benefits
  - Costs
- Description of Feasibility Issues, If Needed
- Status Of Group Approval

Decision Criteria

- GHG reduction potential (CO_2e)
- Cost per ton GHG removed
- Ancillary issues
- Feasibility issues

Stakeholder Decisions

- Voting
  - Votes as needed
  - Identify early consensus actions, barriers
  - Identify final consensus actions, resolve final barriers
- Levels of support
  - Unanimous, Super majority, Simple majority
  - Characterize alternate views

End Product/Final Report

- Executive Summary
- Background, Purpose And Goals
  - Description Of The Process
  - History And Status Of State Actions
  - State Emissions Inventory & Forecast
- Policy Recommendations & Results
  - Agriculture And Forestry
  - Energy Supply
  - Residential, Commercial, Industrial
  - Transportation & Land Use
  - Waste management
  - Cross Cutting Issues
- Appendices

Open Meetings Law

Break

Part 2

- Emissions inventory & forecasts (90)
- Energy and Economic modeling (15)

Arizona GHG Emissions

- Inventory and Reference Case Projections
  - Initial analysis by CCS for further discussion and revision
    - Inventory of historical emissions from 1990 to most recent data year (2000-2004, depending on sector)
    - Projection of emissions to 2020

Coverage

- Six gases per USEPA and UNFCCC guidelines
  - Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O, Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur Hexafluoride (SF_6)
  - Black Carbon considered separately
- All major emitting sectors
  - Electricity
  - Residential, Commercial, Industrial Fuel Use
  - Transportation
  - Agriculture and Forestry
  - Industrial Processes and Other Sources

Inventory Approach

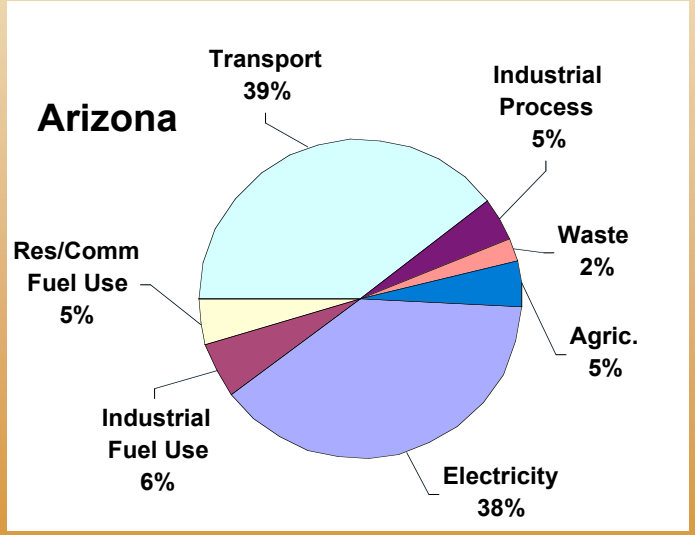
- Standard US EPA and UN methodologies, guidelines, and tools
- Emphasis on transparency, consistency, and significance
- Preference for Arizona or regional data, where available
- Consumption and production-basis emissions from electricity generation
  - Very simplified approach used for initial analysis

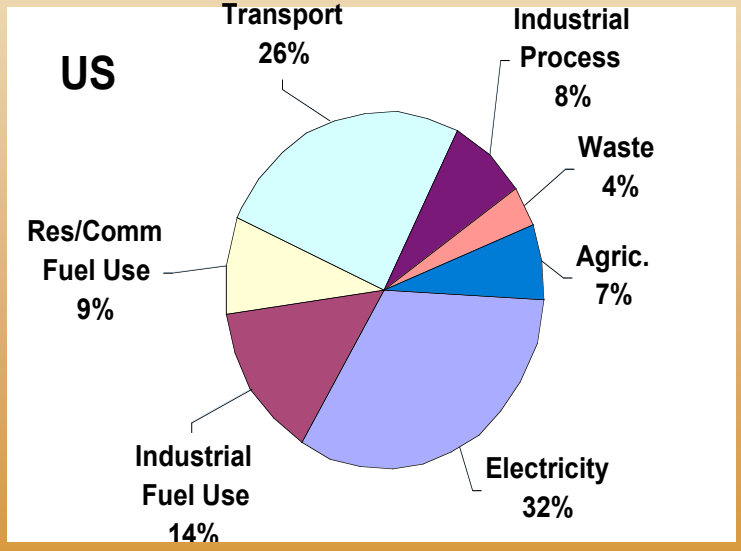
Projection Approach

- Reference case assumes no major changes from business-as-usual
  - Includes approved policies and actions to the extent possible (e.g. Environmental Portfolio Standard)
- Growth assumptions from existing sources
  - Electricity demand growth from AZ Corporation Commission
  - Population and economic forecasts from AZ Department of Economic Security
  - Several assumptions from US DOE's Annual Energy Outlook 2005

Arizona v. US Emissions

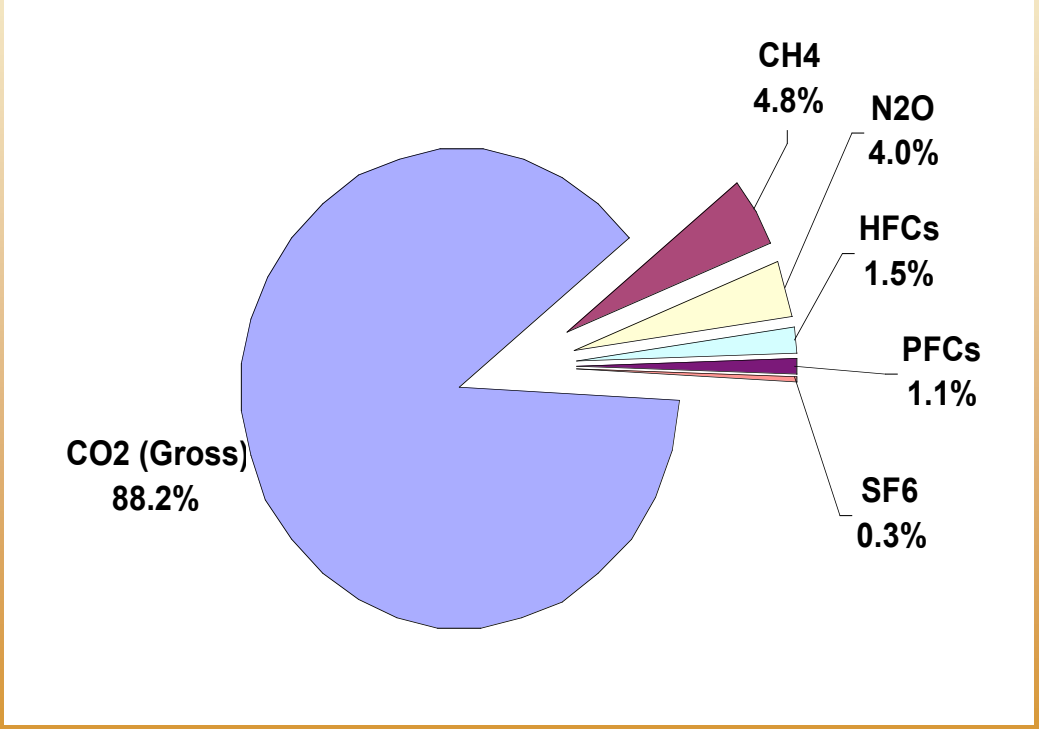
- By Sector, 2000



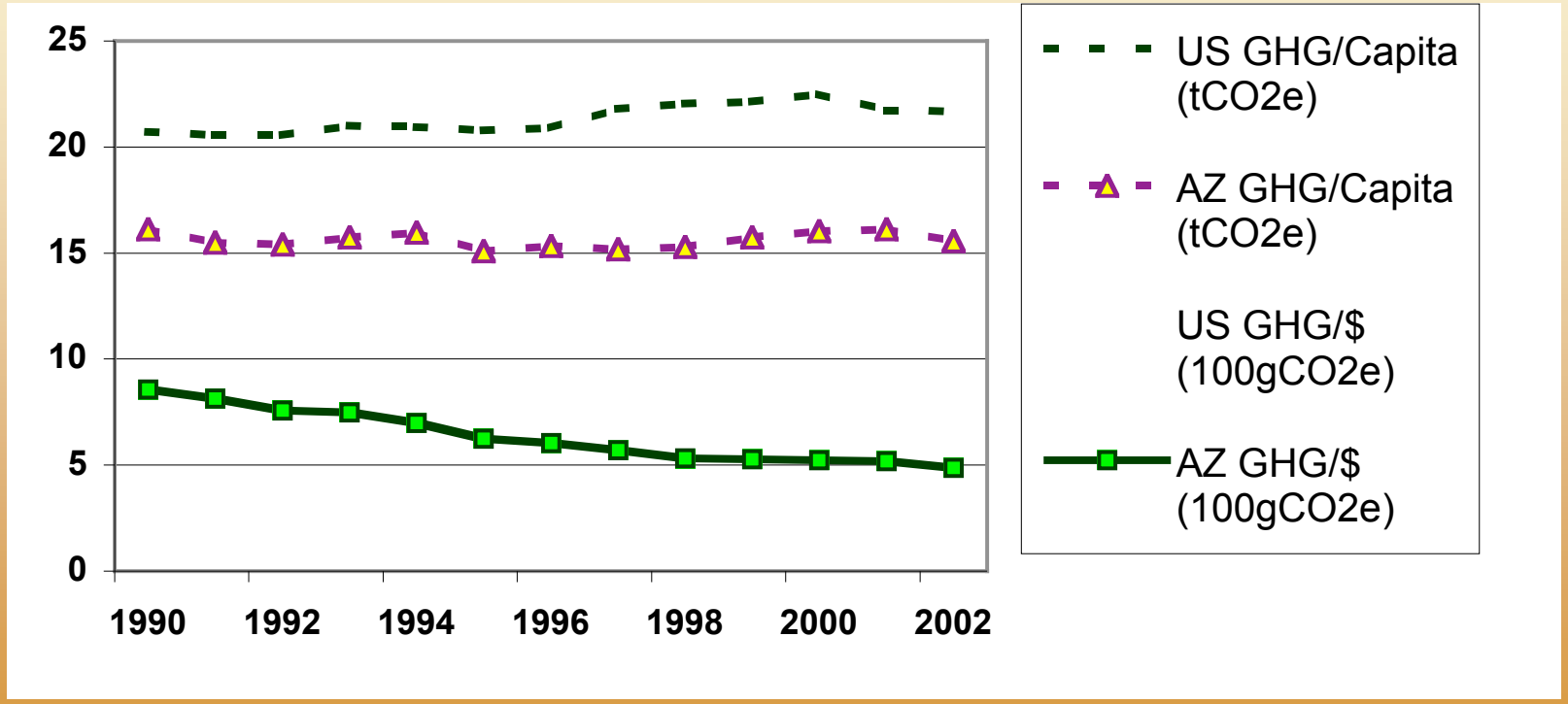


Arizona Emissions

- By GHG Gas, 2000

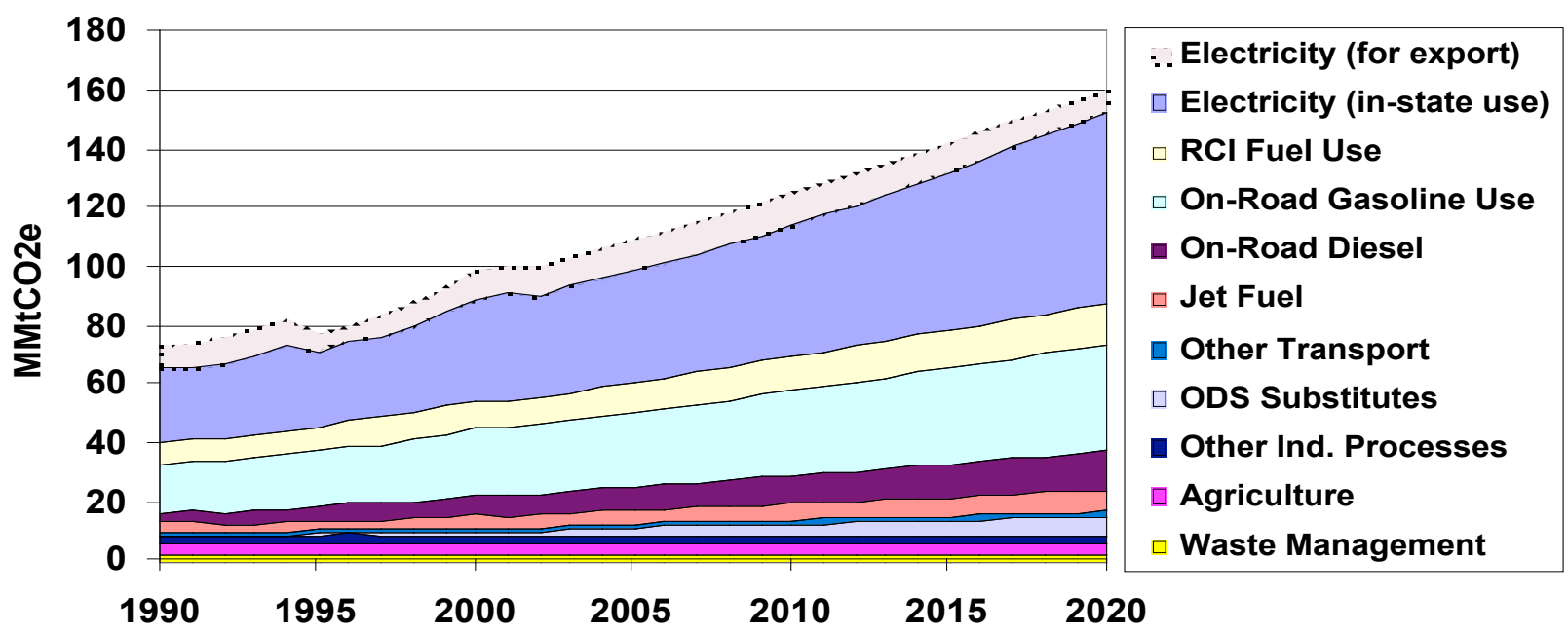


Per Capita and GSP/GDP GHG Emissions, 1990-2002



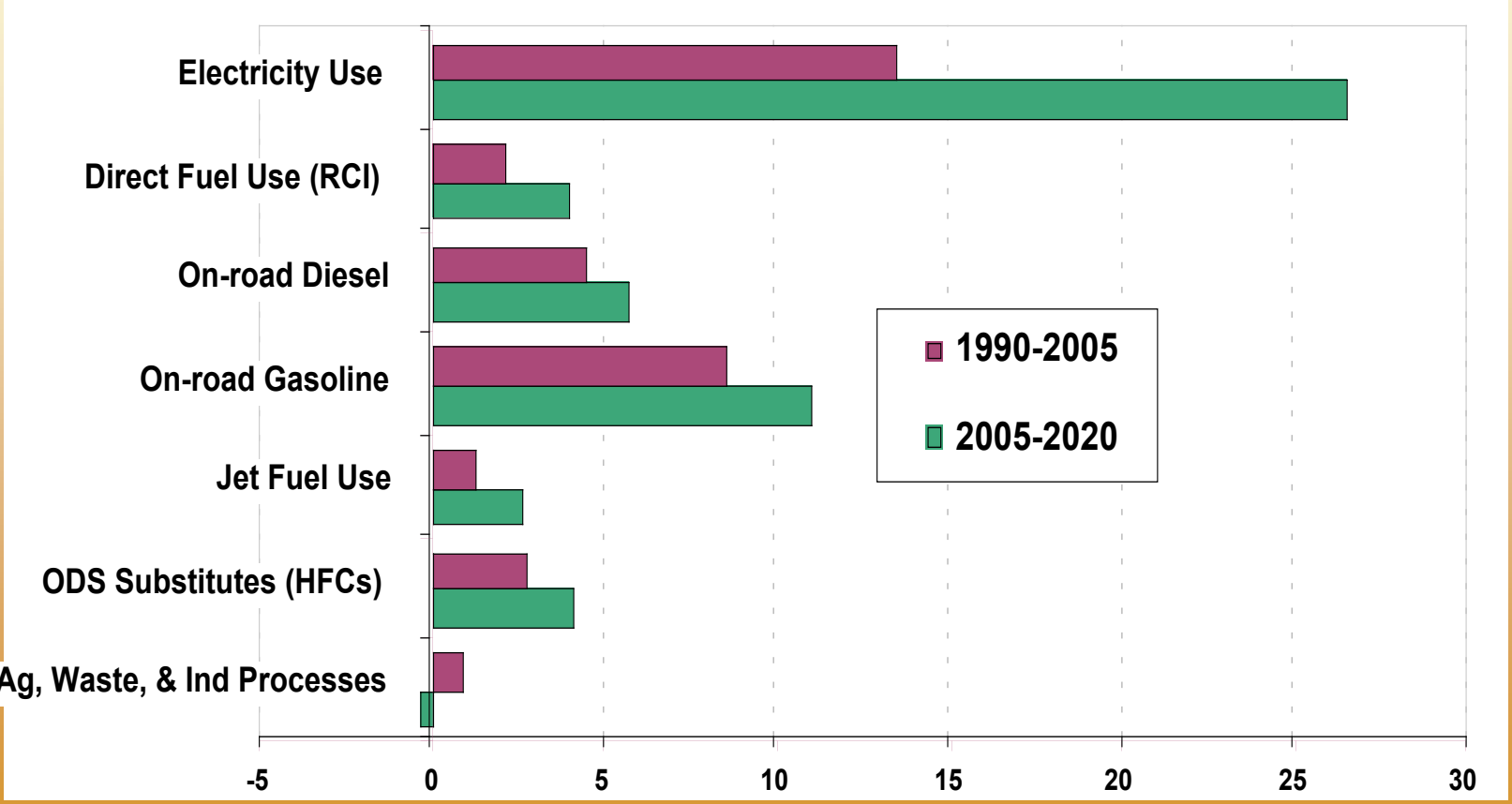
Arizona GHG Emissions

- 1990-2020



*This chart does not show net carbon sinks (forestry and land use) which average slightly over 10 MMtCO2e/year.

Emissions Growth

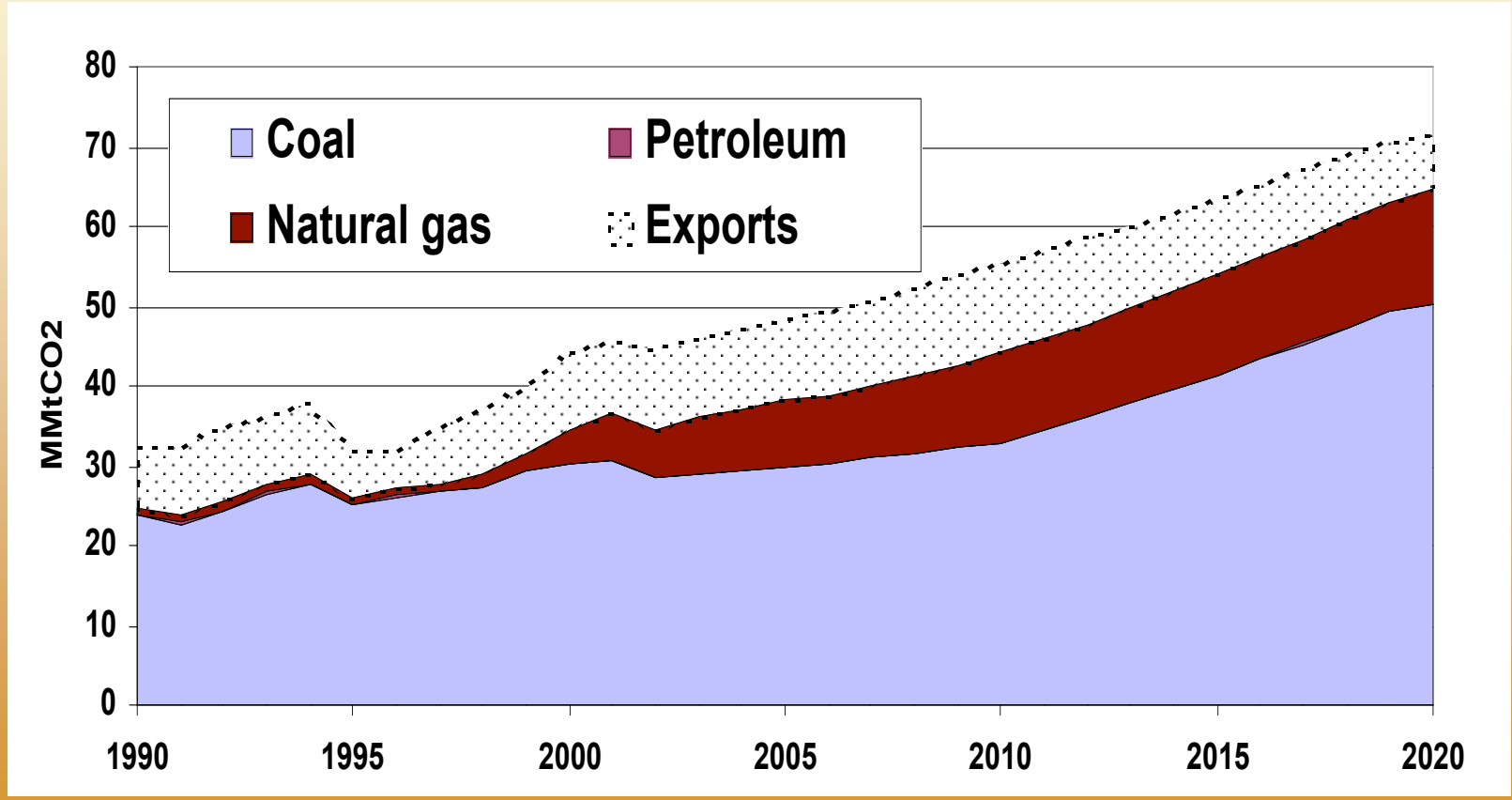


Key Points

- **Consumption v. production methods**

Total Emissions - Consumption-Basis (Excluding Emissions from Net Electricity Exports)				
Gross (excluding sinks)	**66.0**	**89.0**	**114.3**	**152.9**
increase relative to 1990		*35%*	*73%*	*132%*
increase relative to 2000			*28%*	*72%*
Net (including sinks)	**59.3**	**82.3**	**107.6**	**146.2**
increase relative to 1990		*39%*	*81%*	*147%*
increase relative to 2000			*31%*	*78%*
Total Emissions - Production-Basis (Including All In-State Electricity Generation)				
Gross (excluding sinks)	**73.5**	**99.0**	**125.7**	**159.8**
increase relative to 1990		*35%*	*71%*	*118%*
increase relative to 2000			*27%*	*61%*
Net (including sinks)	**66.7**	**92.3**	**118.9**	**153.1**
increase relative to 1990		*38%*	*78%*	*129%*
increase relative to 2000			*29%*	*66%*

Electricity



Electricity

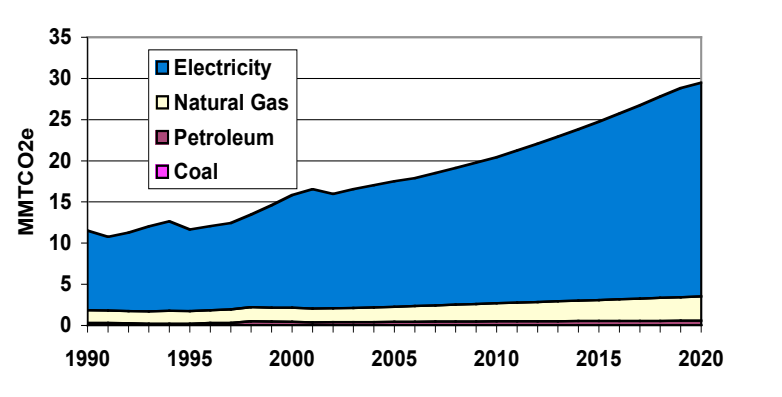
- Data Sources
  - WECC 10-Year Coordinated Plan Summary
  - US DOE Energy Information Administration
    - NEMS Annual Energy Outlook 2005
    - Electric Power Annual – historic generation, consumption
  - ACC Staff Report on Environmental Portfolio Standard
  - Western Regional Air Partnership/ICF, SO_2 trading program, Implementing 10/20 goals and EE
  - Western Resource Advocates Balanced Energy Plan
- Methods
  - Apply existing estimates with 3%/year growth rate (ACC)

Electricity

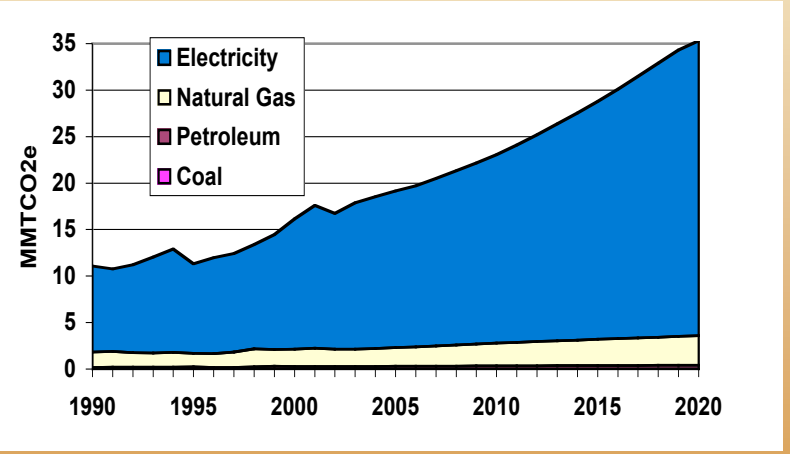
- Key Assumptions and Uncertainties
  - The size, type, and timing of new power sources through 2020
    - 3%/year growth in AZ generation to 2010 (WECC), 2%/year after (NEMS)
    - Through 2010 (78% gas, 18% coal, 5% nuclear), 80/20 coal/gas after 2010
    - Sufficient wind and solar to meet 1.1% renewables requirement

RCI

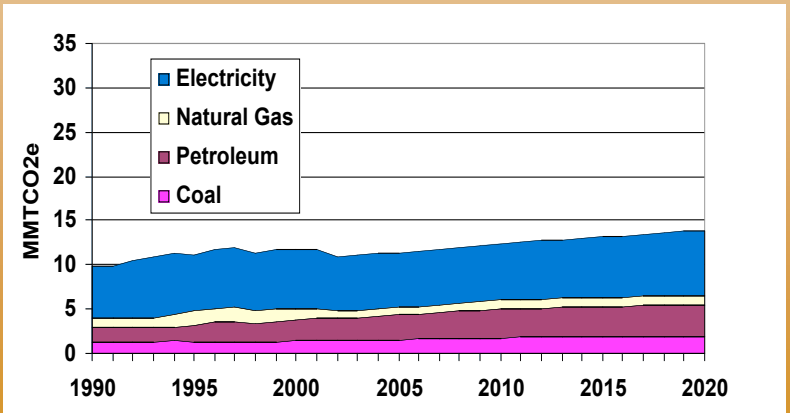
Commercial Sector



Residential Sector



Industrial Sector



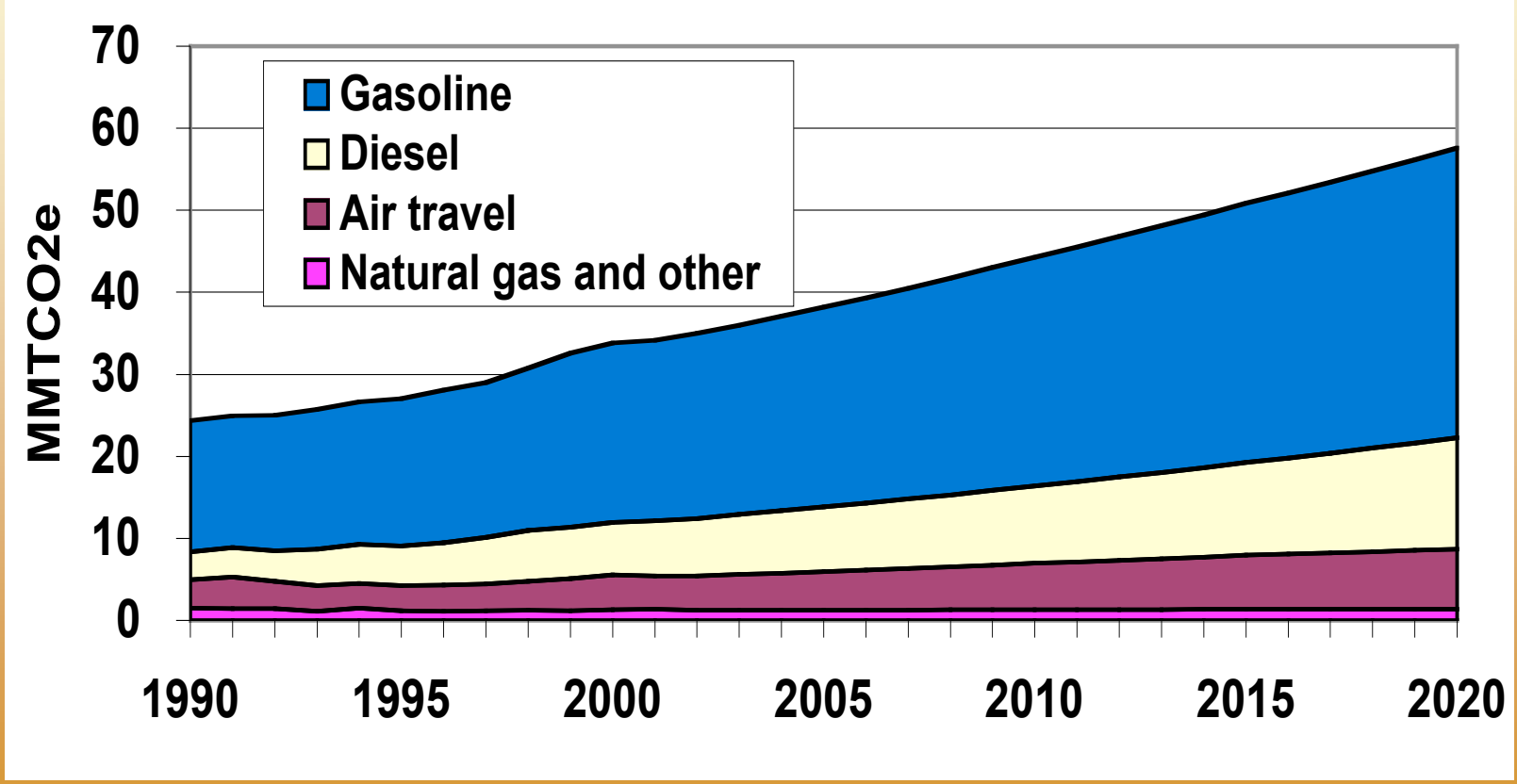
RCI

- Data Sources
  - US DOE Energy Information Administration
    - NEMS Annual Energy Outlook 2005
    - State Energy Data System – historic consumption
- Methods
  - NEMS regional growth rates scaled by Arizona population and economic growth projections

RCI

- Key Assumptions and Uncertainties
  - New refinery and cement plants not yet considered
  - Oil, gas, and coal use growth scaled to Arizona from US DOE regional projections
    - Natural gas growth rates should be informed by in-state gas companies consumption
    - Oil product use can vary significantly over time

Transportation



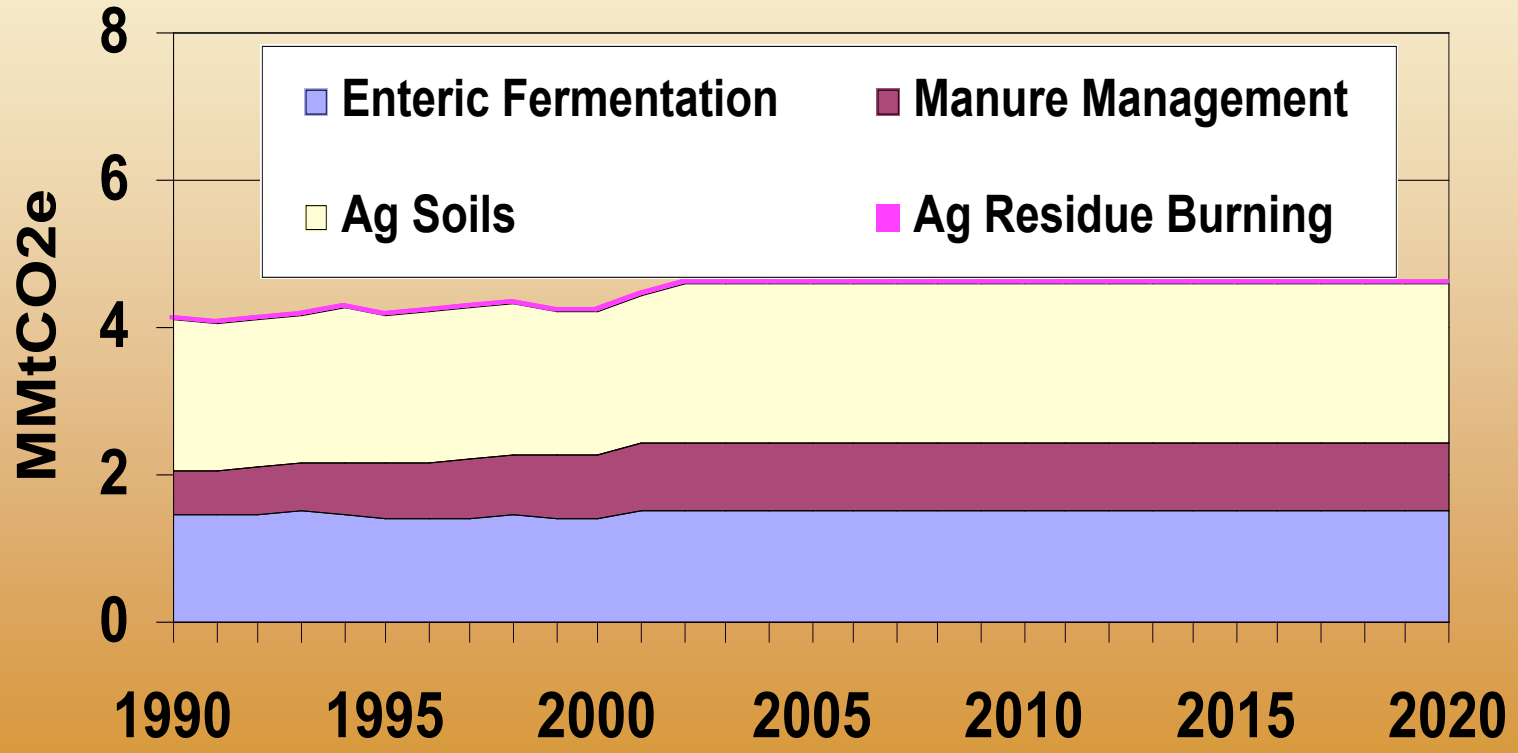
Transportation

- Data Sources
  - AZ DOT fuel consumption data for diesel and gasoline
  - Tellus calculation for ethanol based on information from Maricopa and Pima AG
  - EIA SEDS for natural gas and other fuels
  - AZ DOT MoveAZ report
- Methods
  - Use existing state and federal fuel estimates with GHG conversions

Transportation

- Key Assumptions and Uncertainties
  - Freight and passenger travel (VMT) projections
    - Currently based on AZ DOT's MoveAZ report
  - Projected changes in vehicle fuel economy
    - Currently assumes no change
    - MoveAZ projects significant deterioration, while USDOE Annual Energy Outlook expects slight improvement

Agriculture



Forestry

- Forest carbon stock changes
  - 1987-2002 average annual stock changes
  - Carbon only

Live and dead-standing trees and understory	2.5
Forest floor and coarse woody debris	-3.8
Soils	-5.5
Wood products and landfills	0.0
Total	**-6.7**

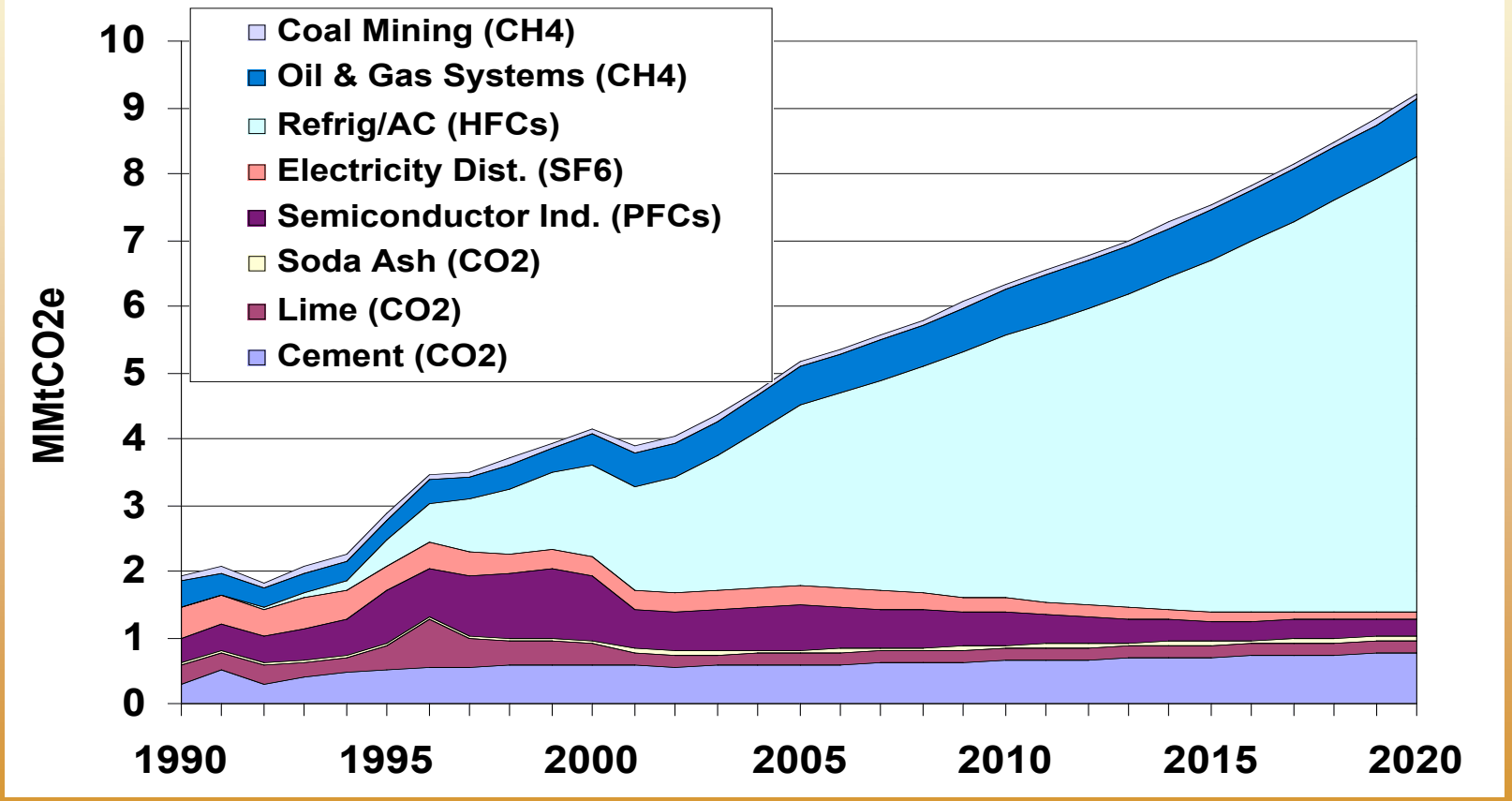
Agriculture & Forestry

- Data Sources
  - Forestry: Forest Inventory Analysis (FIA) data collected by states and USFS
  - Agriculture: USDA data collected by states and usda
- Methods
  - Forestry: USFS FORCARB2 carbon stock change model
  - Agriculture: GHG conversions using EPA methods

Agriculture & Forestry

- Key Assumptions and Uncertainties
  - USFS "forest" definition changes in Southwest over period from 10% to 5% minimum forest cover required per acre
  - Projections of future stock changes must address many changes
  - Rangeland effects need clarification
  - land cover/land use change and harvested wood products require further analysis
  - Manure management practices

Industrial Process



Industrial Process

- Data sources include
  - US Geological Survey
  - US Office of Pipeline Safety
  - US EPA National Inventory of GHG emissions & US Climate Action Report
- Methods
  - Based on US EPA state GHG inventory tool

Industrial Process

- Key assumptions and uncertainties
  - Growth rates
    - PFC – based on national growth (US EPA)
    - Cement and soda ash – based on population
    - lime manufacture, limestone and dolomite and coal mining – assume no growth
    - gas distribution – based on NG consumption

Waste Management

(Million Metric Tons CO2e)	1990	2000	2010	2020
Waste Management	**2.1**	**1.9**	**2.0**	**1.9**
Solid Waste Management	1.7	1.3	1.4	1.1
Wastewater Management	0.4	0.5	0.7	0.8

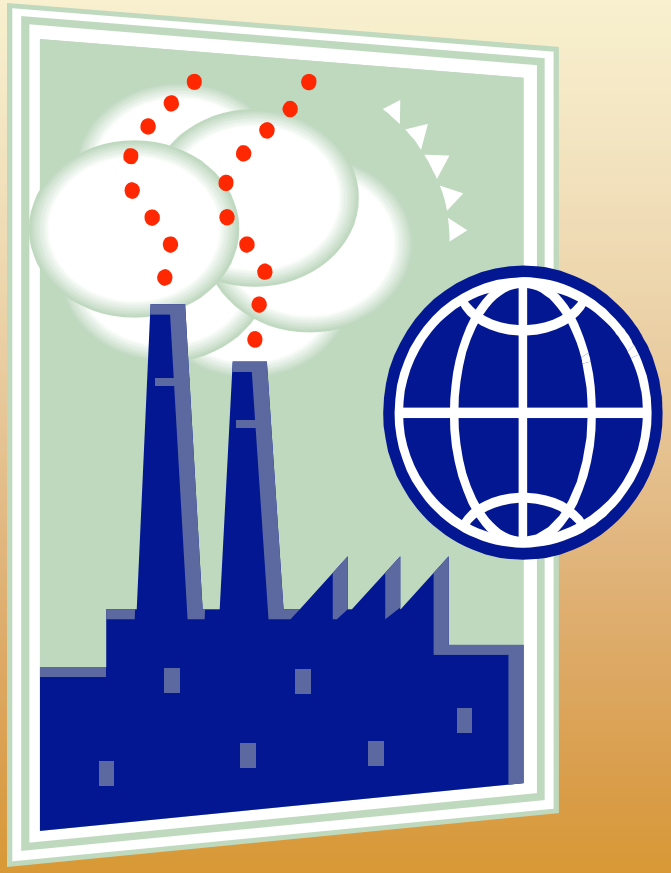
Waste Management

- Waste Management emissions
  - Data sources
    - Biocycle magazine
    - Information collected by US EPA from state solid waste offices for State GHG Inventory Tool
  - Methods
    - Based on US EPA ghg inventory tool
  - Key assumptions and uncertainties
    - emissions grow with population

Black Carbon

- One of two carbonaceous aerosol species – BC and Organic Carbon (OC)
- Also known as light absorbing carbon (LAC), and elemental carbon (EC)
- Absorbs solar energy and warms the troposphere (like GHG's)

Sources of Black Carbon



- Fossil Fuel Combustion
- Biomass Combustion
- Other (Minor) Sources

Analysis Methods

- Apply methods similar to those used in the U.S. northeast
- Extend the analysis to cover all BC sources
- Develop mass BC and OC emission estimates using:
  - Data from the WRAP
  - Arizona particulate matter data and speciation profiles

Analysis Methods

- Use the modeling work of Jacobson (Stanford University) to convert mass emissions to CO_2e
- Jacobson's modeling produced climate response factors of 330 to 700 tons CO_2 per ton of BC
- Assemble the CO_2e estimates into the same sector-level estimates as the gases

Analysis Methods

- Example BC and OC Mass Fractions – Wildfires/Prescribed Burns:

WRAP Draft 2002 Inventory				This Study	
Prescribed Fire – Piled Fuels		Prescribed/Wildfires – Non-Piled Fuels		Prescribed Fires and Wildfires	
Weight Fraction					
BC	OC	BC	OC	BC	OC
0.072	0.54	0.062	0.48	0.075	0.532

Analysis Methods

- Example BC and OC Mass Fractions – Mobile Source Sector:

Sector	Subsector	WRAP		This Study	
		Weight Fraction			
		BC	OC	BC	OC
Onroad Gasoline	Exhaust	0.239	0.518	0.169	0.597
	Tire Wear	0.609	0.2175	0.22	0.472
	Brake Wear	0.028	0.972	0.0261	0.107
Onroad Diesel	Light Duty Exhaust	0.613	0.303	0.613	0.303
	Heavy Duty Exhaust	0.75	0.189	0.75	0.189
	Tire Wear	0.609	0.2175	0.22	0.472
	Brake Wear	0.028	0.972	0.0261	0.107
Nonroad Gasoline		0.239	0.518	0.0801	0.655
Nonroad Diesel		0.75	0.189	0.7411	0.187

Analysis Methods

- Example calculation of the CO_2e emissions for 10 tons of PM_{10} from onroad diesel exhaust:
  - BC mass = (10 tons PM_{10}) x (0.613 ton BC/ton PM_{10}) = 6.13 short tons BC
  - Low estimate CO_2e = (6.13 tons BC) (330 tons CO_2e/ton BC+OM) (3 tons BC+OM/ton BC) (0.907 metric ton/ton) = 5,504 metric tons CO_2e
  - High estimate CO_2e = (6.13 tons BC) (697 tons CO_2e/ton BC+OM) (3 tons BC+OM/ton BC) (0.907 metric ton/ton) = 11,626 metric tons CO_2e

Results

Sector	Subsector	CO_{2e} BC (Short Tons)	CO_{2e} OM (Short Tons)	CO_{2e} Low (Metric Tons)	CO_{2e} High (Metric Tons)
Electric Generating Units (EGUs)	Coal	193	250	173,041	365,545
	Oil	1.1	0.34	994	2,101
	Gas	0	86	0	0
Non-EGU Fuel Combustion (Residential,Commercial, and Industrial)	Coal	5.7	7.5	5,161	10,902
	Oil	22	9.5	19,692	41,599
	Gas	0.03	219	0	0
	Other	170	884	1,985	4,194
Onroad Gasoline (Exhaust, Brake Wear, & Tire Wear)		192	670	82,973	175,278
Onroad Diesel (Exhaust, Brake Wear, & Tire Wear)		119	142	104,966	221,738
Aircraft		50	25	44,592	94,200
Other Energy Use	Nonroad Gasoline	52	509	0	0
	Nonroad Diesel	557	169	500,018	1,056,274
	Nonroad Other	338	106	303,511	641,160
	Other Combustion	8.7	72	237	500
Industrial Processes		42	606	326	690
Agriculture		27	1,362	0	0
Waste Management	Landfills	0.12	7.3	0	0
	Incineration	5.3	9.8	4,741	10,015
	Open Burning	986	1,830	885,686	1,870,987
Wildfires/Prescribed Burns		8,400	71,501	0	0
Miscellaneous		94	1,446	86	182
	Totals	**11,262**	**79,909**	**2,128,011**	**4,495,364**

Results

- 2002 BC Mass Emissions = 11,262 short tons
- CO_2E = 2.1 – 4.5 million metric tons
- BC CO_2E is about 3 to 6 percent of the entire gaseous CO_2E
- Except for the open burning sector, biomass burning BC was excluded from the CO_2E estimates

Results

- Open burning: largest contributor (42%)
- Nonroad diesel (e.g. construction): second largest (23%)
- Nonroad other (trains): contributed (14%)
- Coal-fired EGUs: 8%
- Onroad diesel: 5%
- Onroad gasoline: 4%

Modeling Options

- Principles
  - Simple, flexible, accurate, transparent, affordable
- Energy supply choices
  - Simplified desktop
  - Complex dynamic market simulation
- Macroeconomic
  - REMI and other state models

Work group issues

- Energy Supply
  - Projections of new generation sources
  - Consumption-based approach (e.g. utility fuel mix)
  - Modeling
- RCI
  - Growth in activity (e.g. housing starts), fuel and electricity use
  - Closer assessment of process emissions (semiconductors, cement)
  - Emissions implications of new refinery
- Transportation and Land Use
  - Examination of VMT projections
  - Assumptions for changes in fuel economy
- Ag and Forestry
  - Clarification of USFS numbers, incorporation of new data
  - Rangelands, land use change, wood products, and manure management practices
- Other
  - Waste management emissions
  - Black carbon

Next steps

- Incorporate today's feedback
- Provide detailed versions to work groups
  - Identify potential needs for revision
  - Identify alternate data sources, methods, assumptions
- Report back to stakeholders

Break

Part 3

- Opportunities & issues (20)
- Technical work groups, next steps (20)
- Public input (10)

Opportunities & Issues

- Major opportunities
  - Sectors and actions
  - Implementation mechanisms
- Major obstacles
  - Technical and economic barriers
  - Implementation barriers

Technical Work Groups

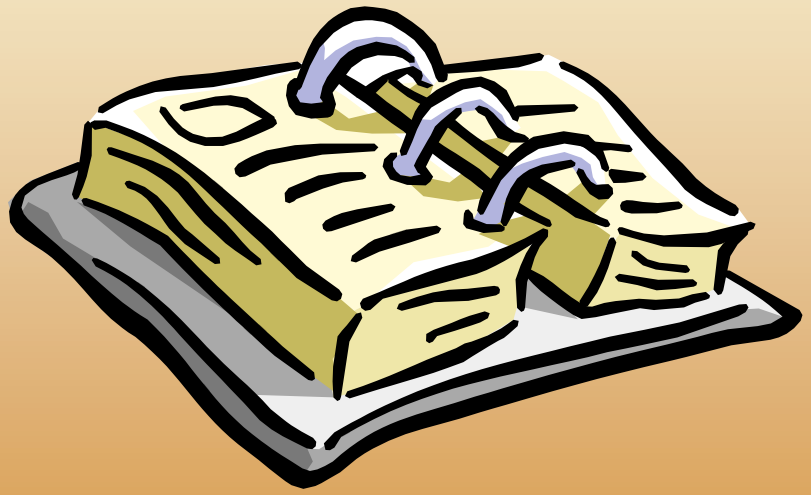
- Advisory group assignments
  - Energy Supply, including waste energy recovery
  - Residential, Commercial, Industrial
  - Transportation and Land Use
  - Agriculture and Forestry
  - Cross Cutting Issues

Next Steps

1. Review emissions inventory and projections
2. Review and expand list of potential options
3. Identify initial priorities for analysis
4. Review proposed technical work plan
5. Prepare for next stakeholder meeting

Agenda Next Meeting

1. Review of emissions inventories and projections
2. Review of potential Arizona policy actions
3. Review of initial priorities for evaluation
4. Review of technical work group plans, including modeling



Public Input